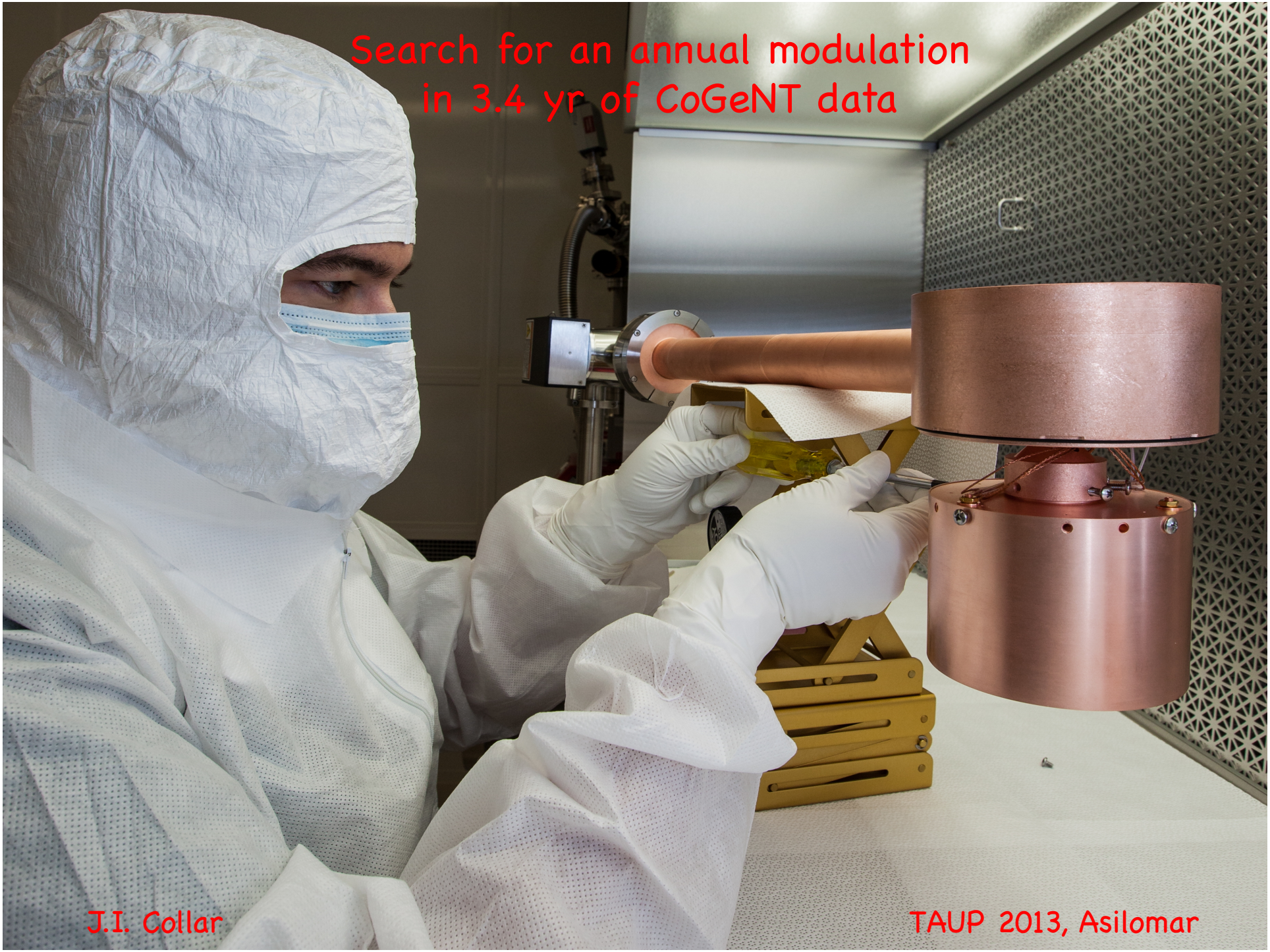
Search for an annual modulation
in 3.4 yr of CoGeNT data
J.I. Collar
TAUP 2013, Asilomar

A brief chronology of past CoGeNT results

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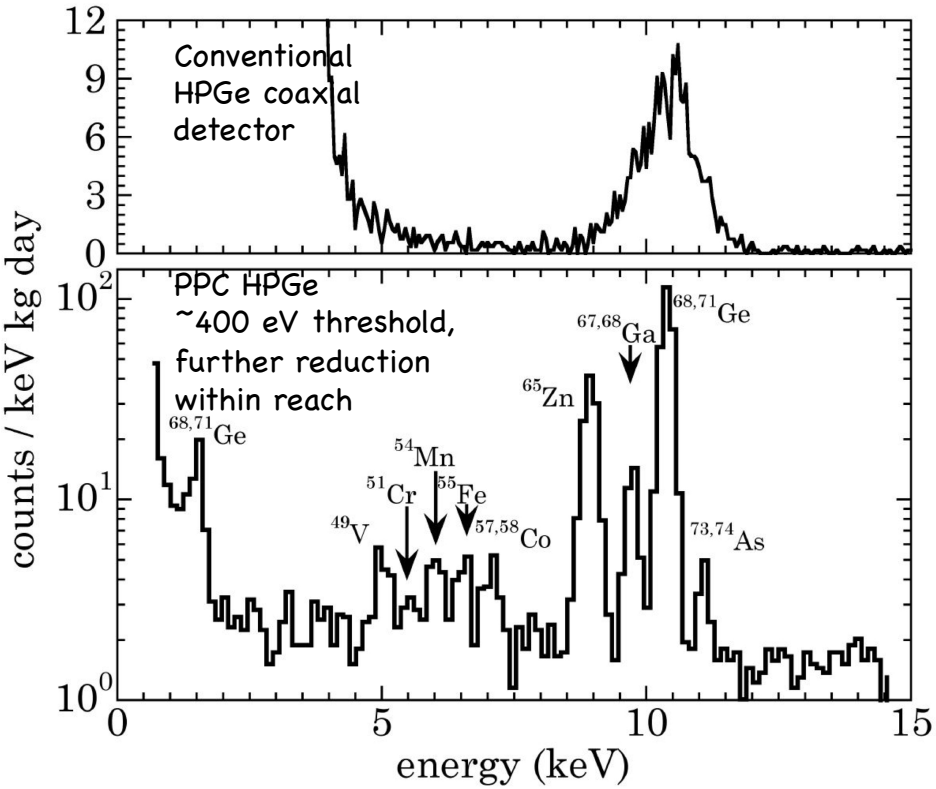

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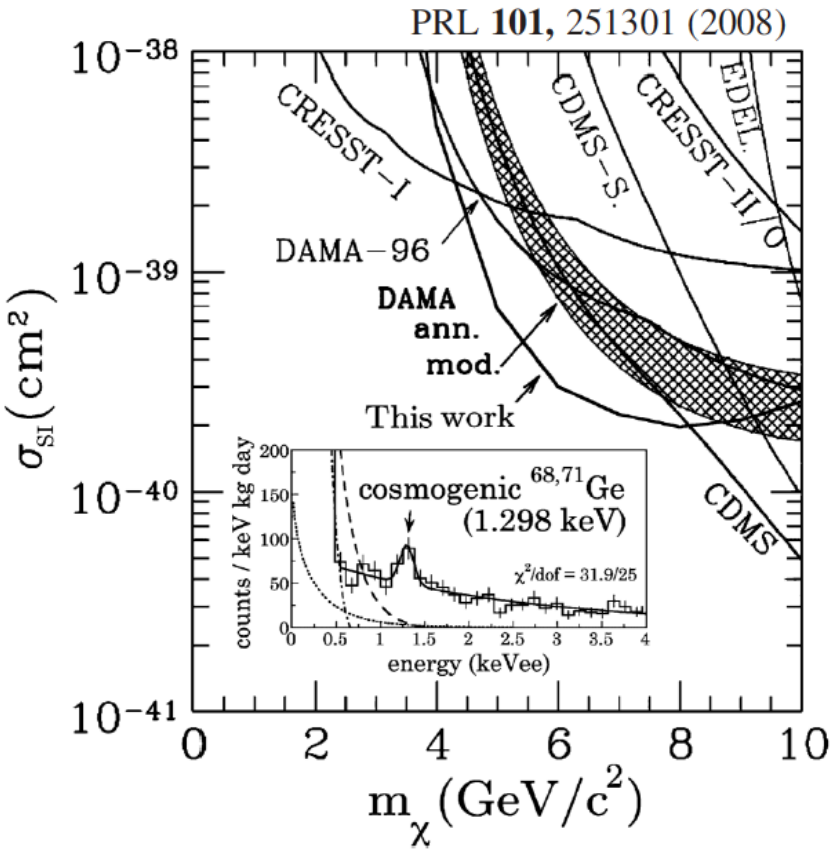

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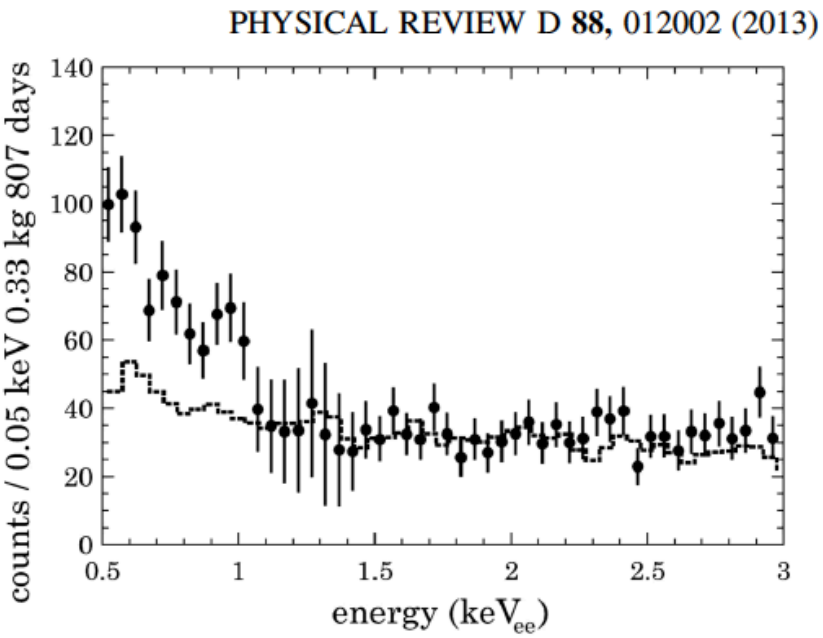

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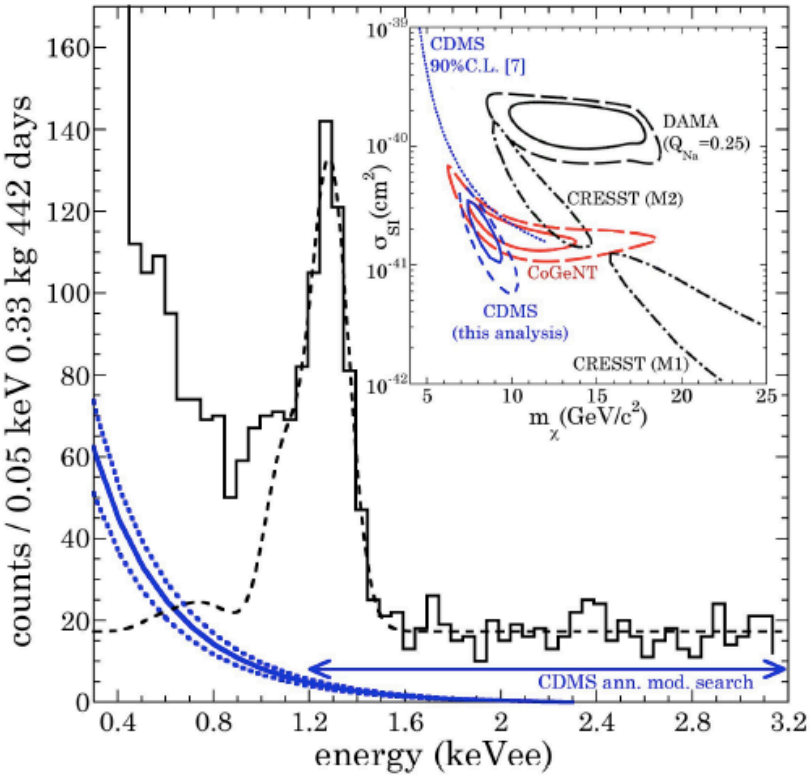

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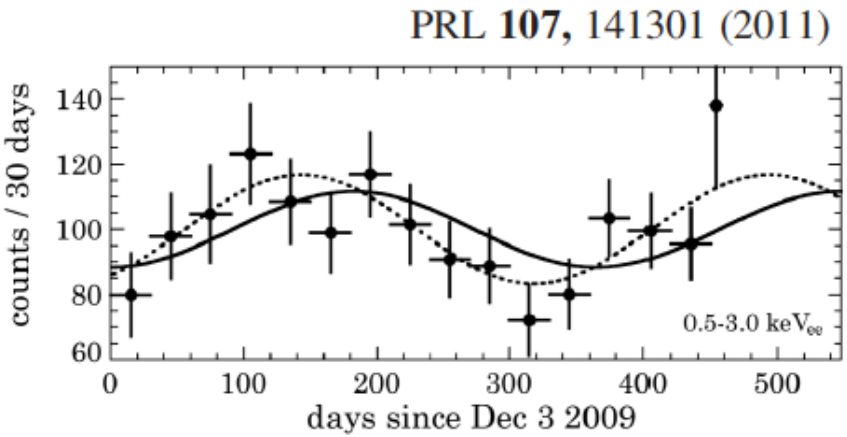

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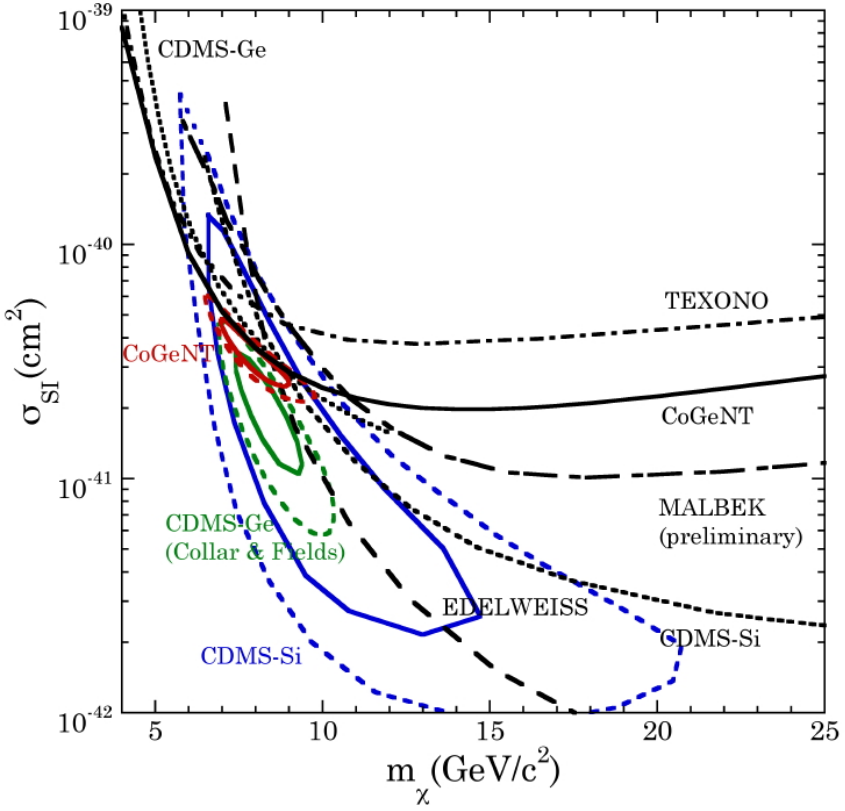
- Much ensuing action: CRESST and CDMS-Si anomalies, XENON exclusions (and criticisms thereof), etc. TBD.

Ge-Si detector landscape (just part of the story)



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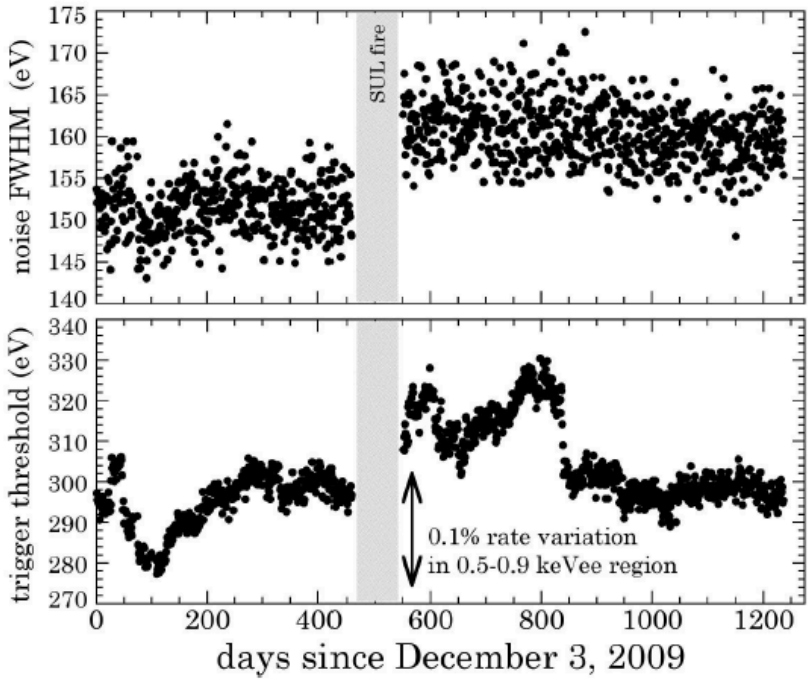

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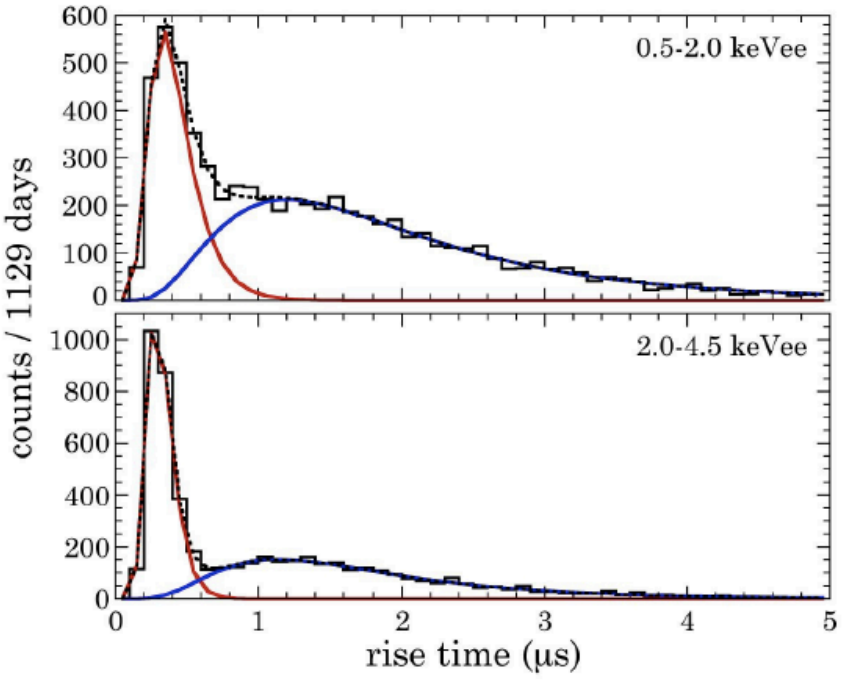
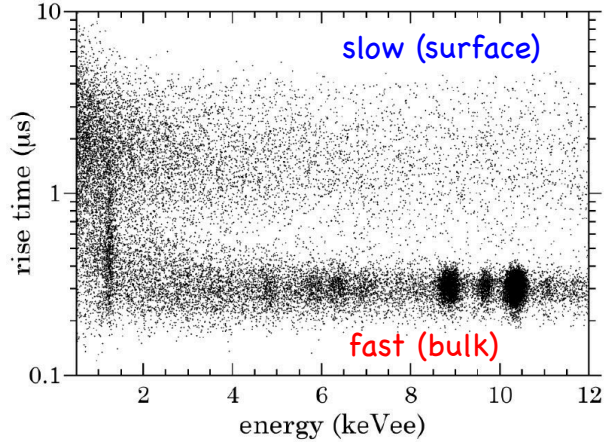
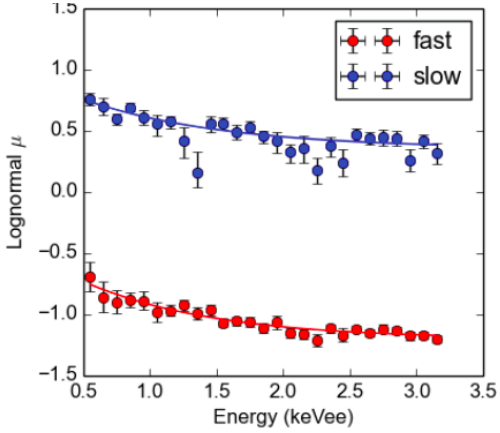
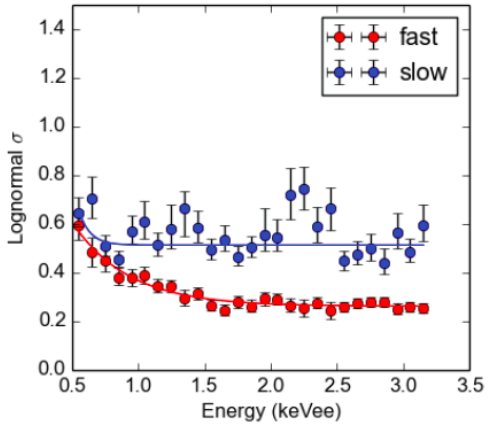


Regions selected for "toy" analysis







M. Bellis et al., in preparation.

See also poster by M. Kos.

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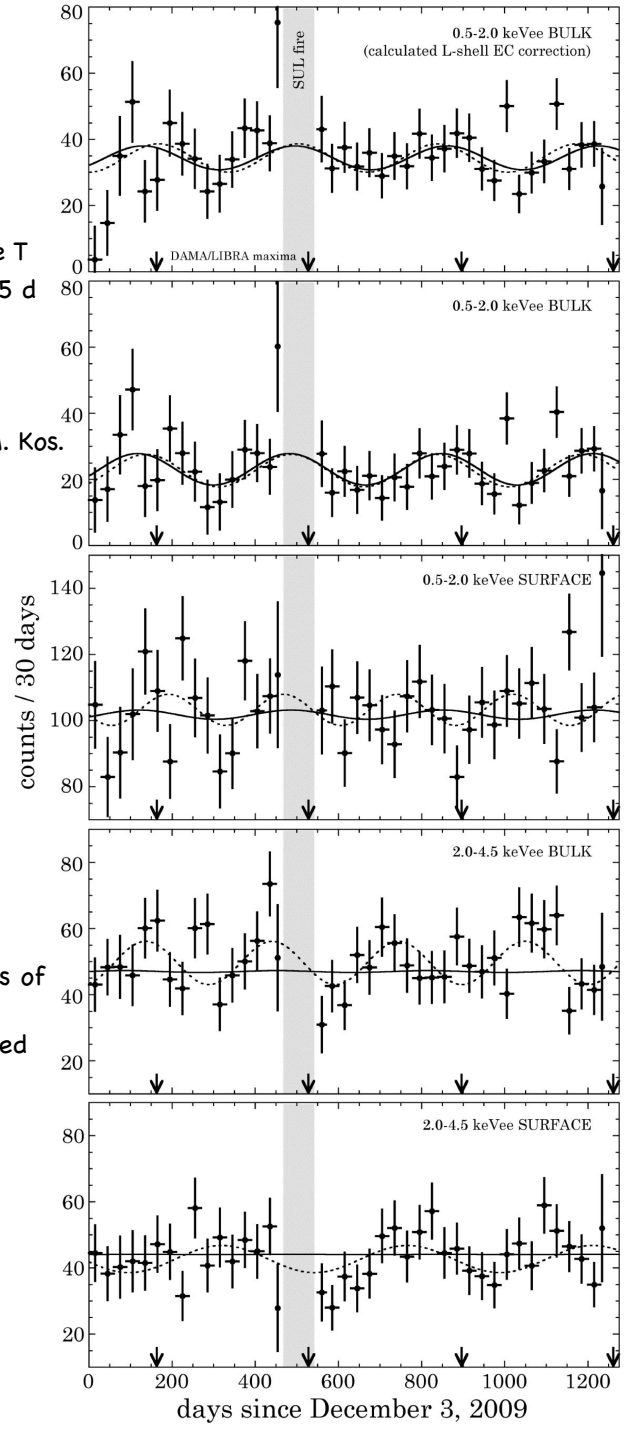

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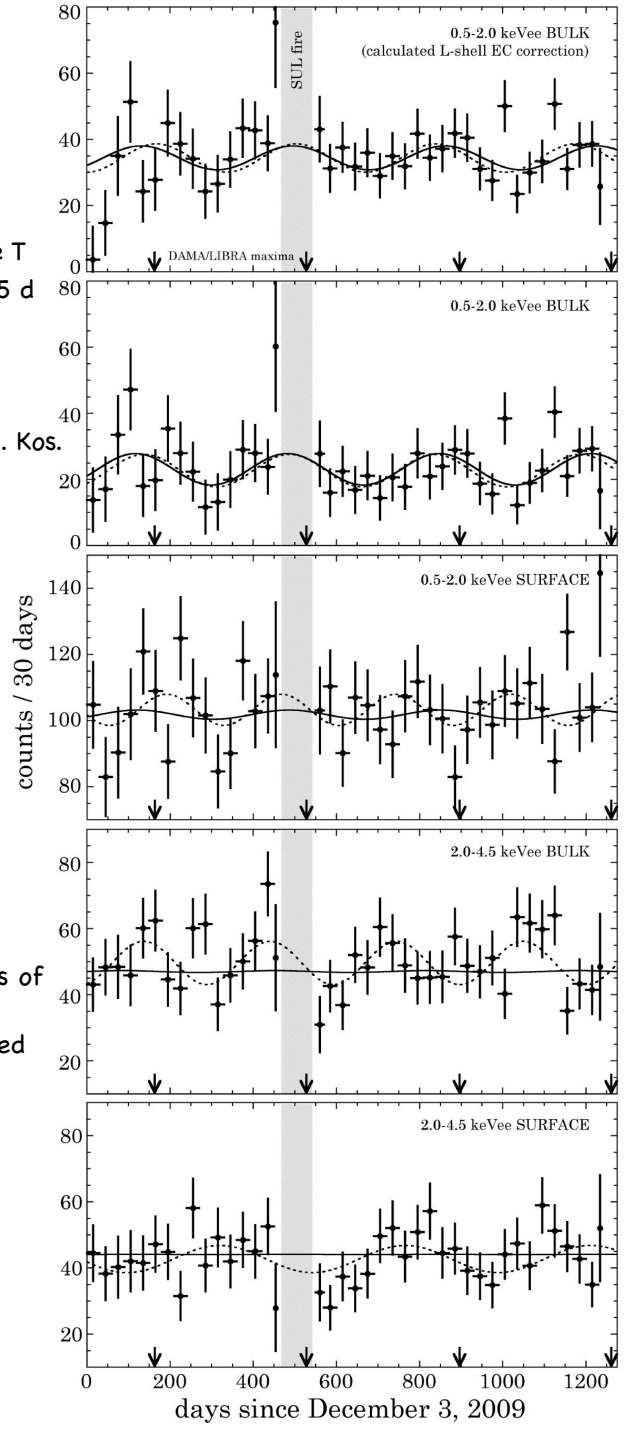

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- Modulation amplitude is 4-7 times larger than that predicted by the SHM. Finding an absence of modulation would have severely constrained non-standard halo models as explanations for DAMA/LIBRA.

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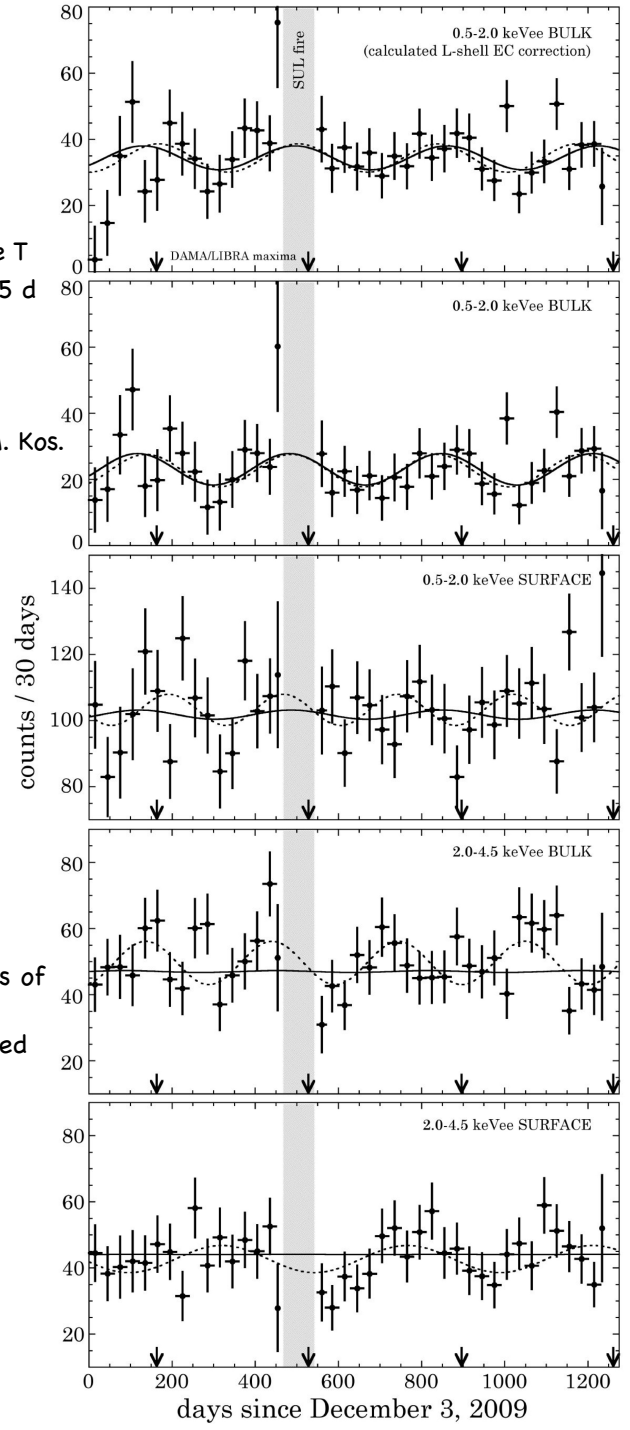

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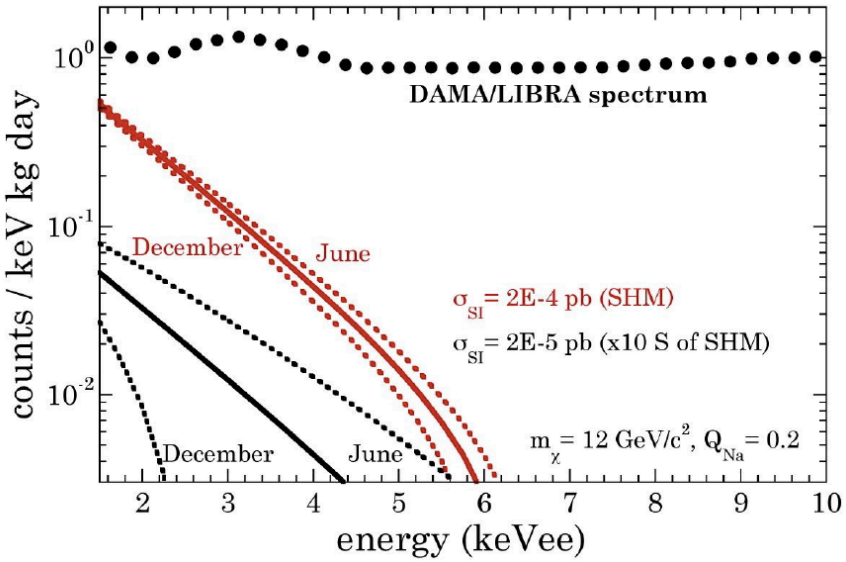

Rough sketch: two WIMPs inducing the same DAMA/LIBRA observable (absolute modulation), but having a different fractional modulation. A SHM cannot induce the large modulation case.

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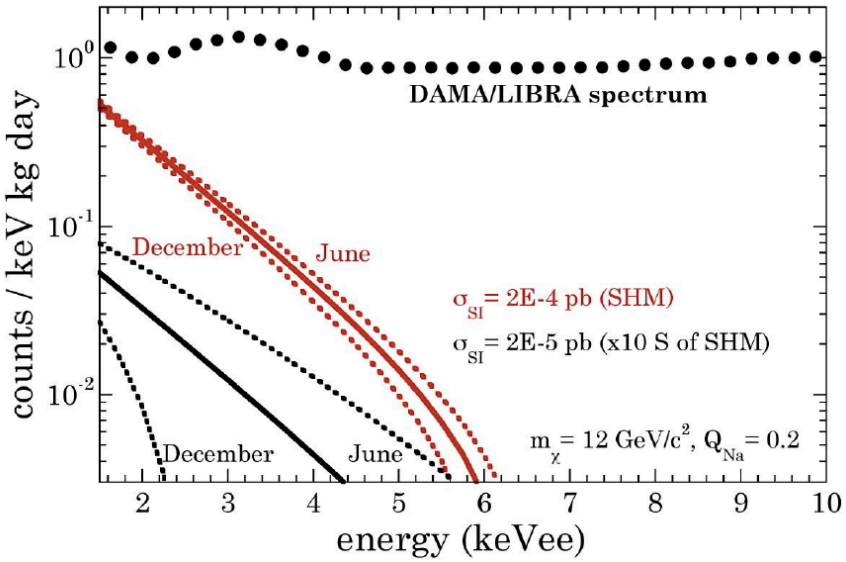

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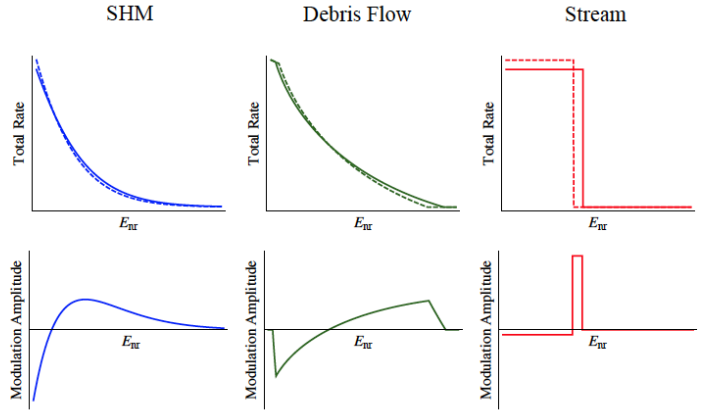

e.g., arXiv:1209.3339

FIG. 3: A comparison of the shapes of the total rate shown at two periods of the year, corresponding to the times of year at which the rate is minimized and maximized, as well as the modulation amplitude, for three different halo components: SHM (left), debris flow (middle), stream (right). The normalization between panels is arbitrary.

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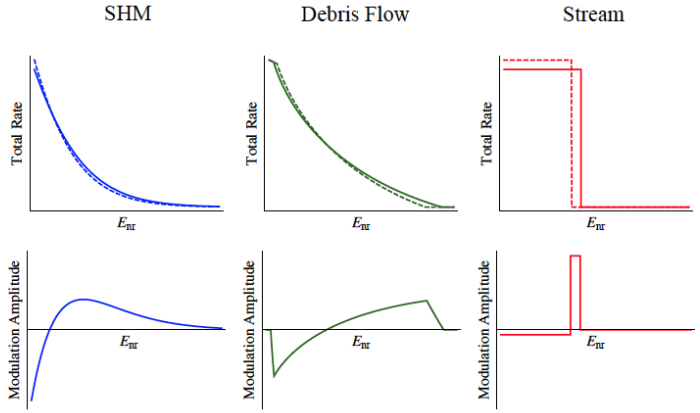

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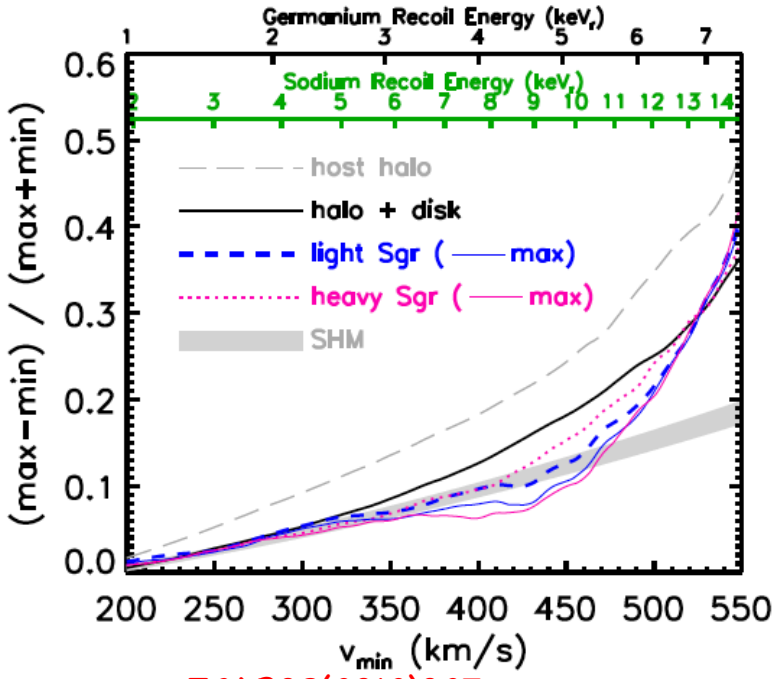

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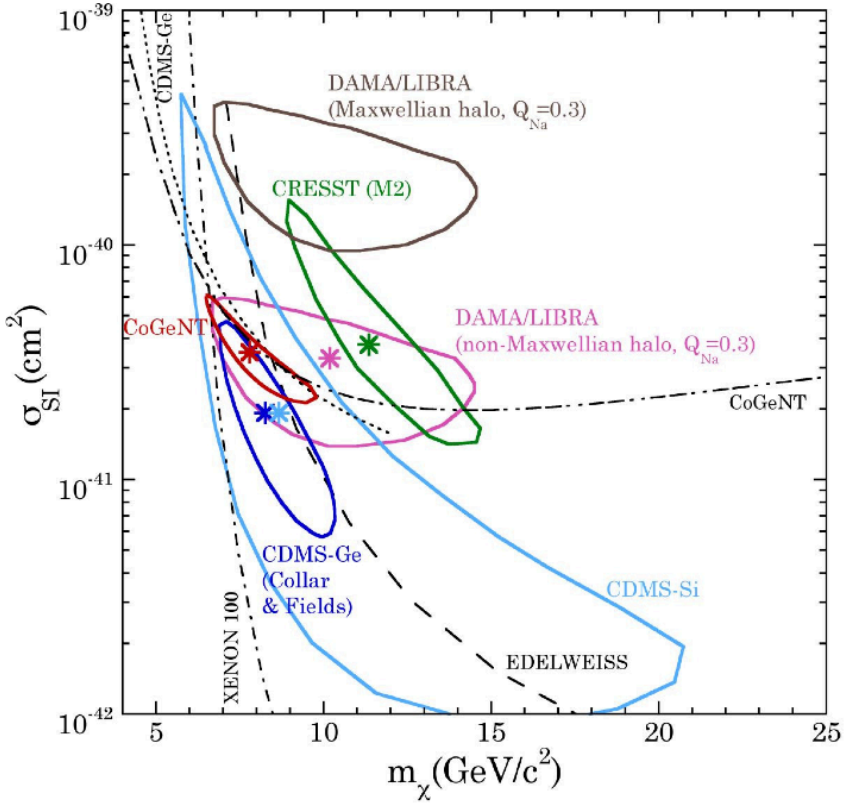

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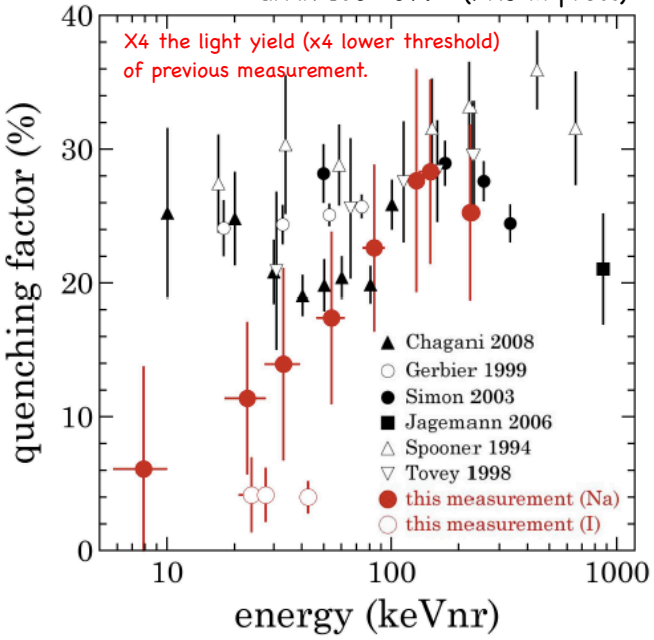
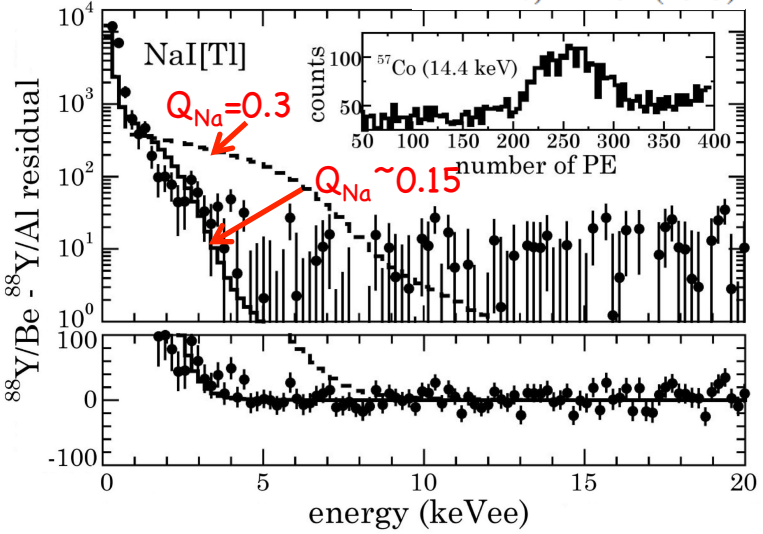
arXiv:1302.0796 (PRC in press)



Full disclosure: I am the author of these two measurements, but was hoping to find Q_{Na}~0.4… (see arguments in PRD 82 (2010) 123509)

PRL **110,** 211101 (2013)



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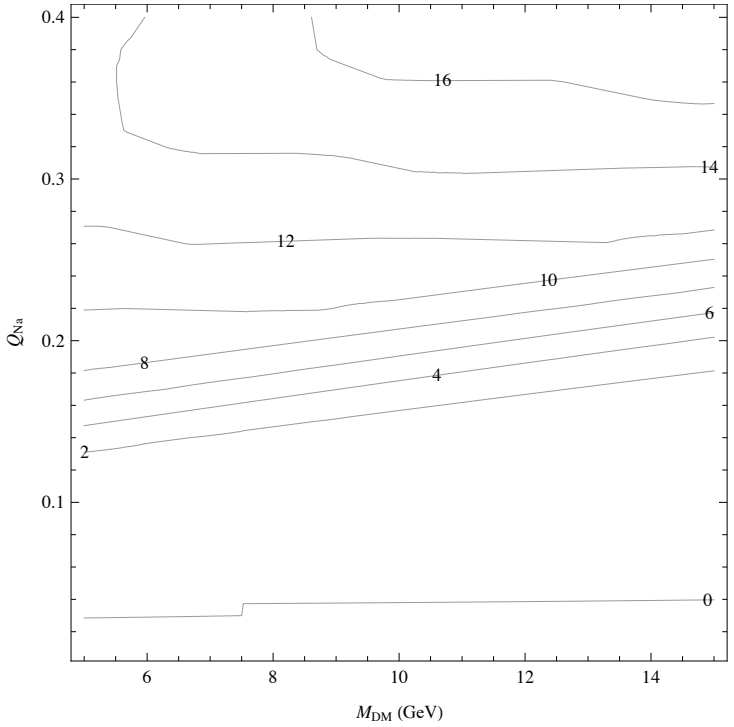
Expected modulation amplitude in CoGeNT (upper limit) as a function of Q_{Na} and WIMP mass, taking DAMA/LIBRA as the input, and removing astrophysical uncertainties. Units are the same as in CoGeNT (counts/30d) plot a few transparencies above.

Plot by Chris Kelso, using the halo-independent formalism by P. Fox *et al.* (PRD 83 (2011) 103514, see also PRD 85 (2012) 043515).



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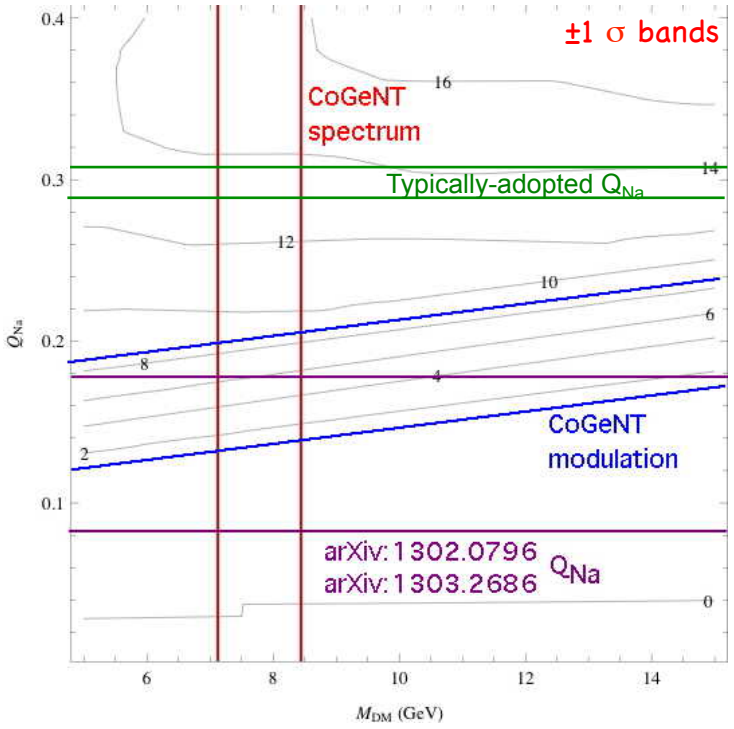

If Q_{Na} is the standard ~0.3, then move on, there is nothing to see here...

A few personal impressions:

- If Q_{Na} for 2-6 keVee in NaI[Tl] is the usual ~0.3, then DAMA/LIBRA and CoGeNT's observations most probably have nothing to do with each other, not within a WIMP context. It would then seem possible to constraint non-SHM scenarios for DAMA, using CoGeNT data.

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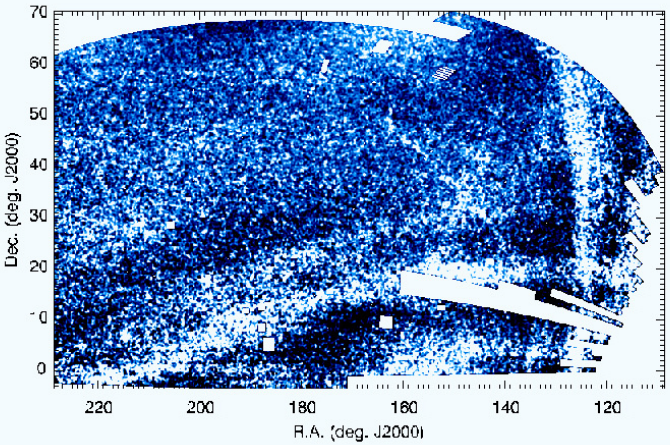
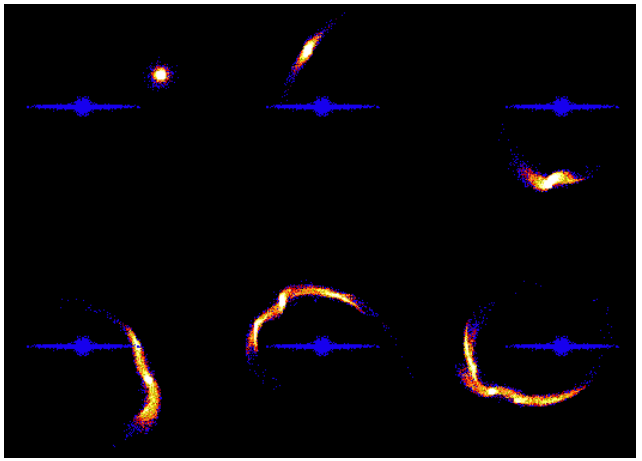


SLOAN star-count map
showing Milky Way tidal streams



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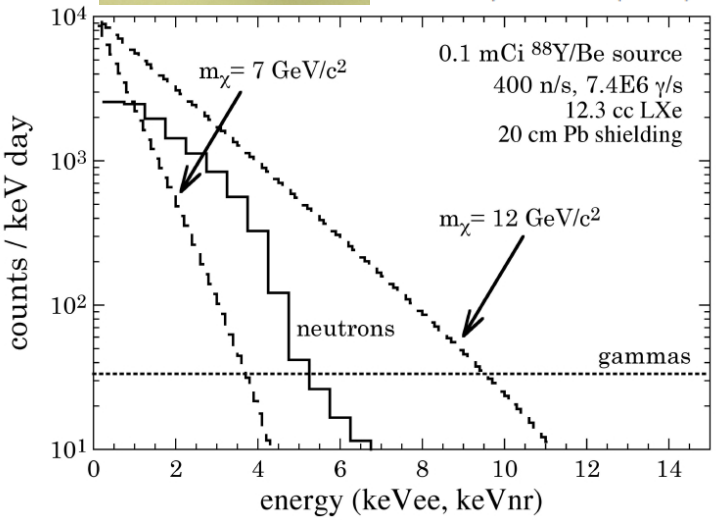
- We should not be left forever wondering about XENON-100 excluding this low-mass ROI or not: *in situ* calibrations with the Y/Be source described in PRL 110 (2013) 211101 should settle this issue, once for all. LUX and XMASS results should also cast light (both feature significantly lower thresholds).

PRL **110,** 211101 (2013)



Standing challenge to XENON-100:
we hear they will gallantly take it up.

(choose your own exiting quote here)

- "In so far as a scientific statement speaks about reality, it must be falsifiable; and in so far as it is not falsifiable, it does not speak about reality". K. Popper

- "Everything should be made as simple as possible, but not simpler". A. Einstein

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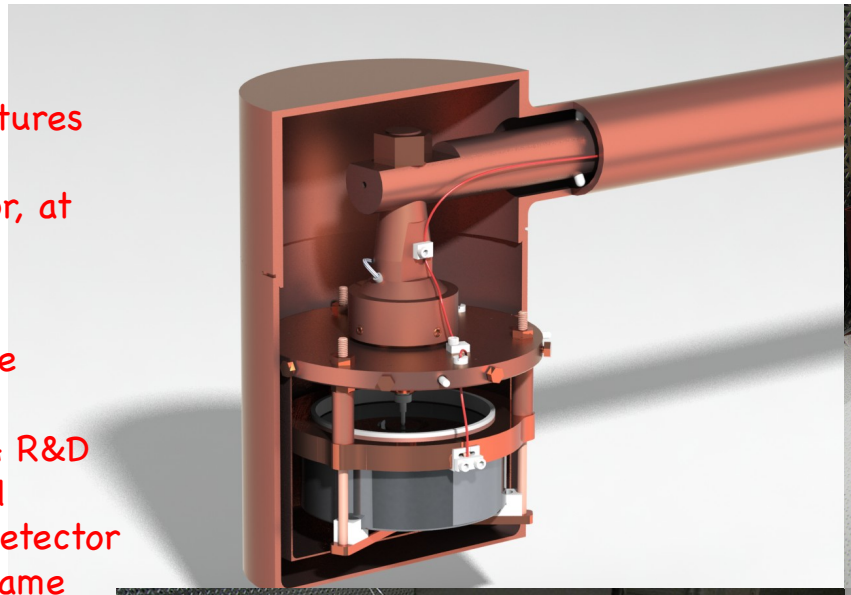
(We have not even opened the particle physics can-of-worms today. However, old grandpa Al is very disappointed at you, if you were really expecting the spherical cow)

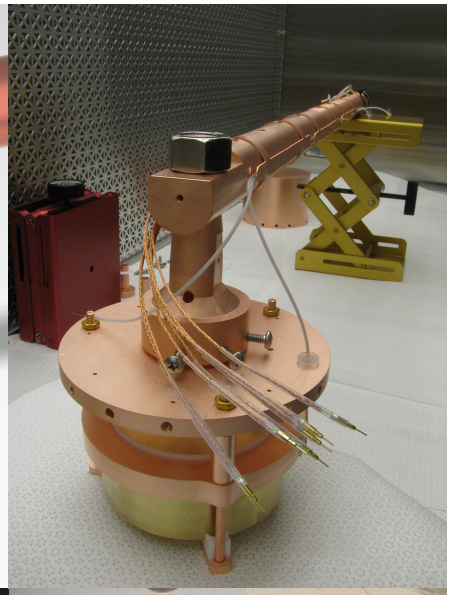
C-4: coming up very soon

* First C-4 detector features ~1/3 of the noise of the existing GoGeNT detector, at ~x3 its mass (1.3 kg)

* Not a one-off: its noise characteristics are now reproducible (CANBERRA R&D supported by NSF award PHY-1003940). Second detector expected to reach the same noise figure at 2 kg, the realistic PPC maximum.

* C-4 aims at a x10 total mass increase, ~x20 background decrease, and substantial threshold reduction. Soudan is our laboratory of choice, assuming its continuity.



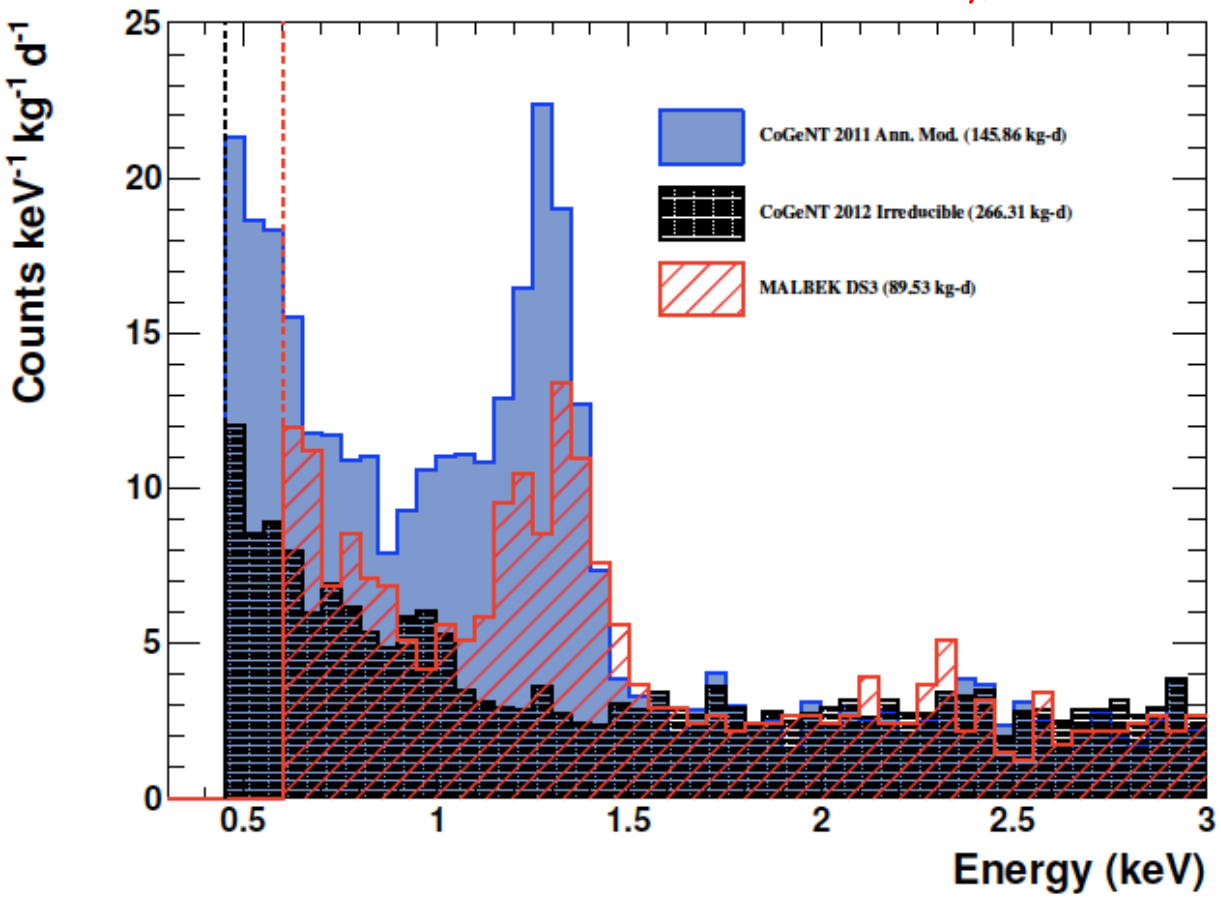


Design and assembly of ULB cryostat at PNNL

Appendix: MALBEK and CoGeNT side-to-side

(apologies, I am a speaker in another session during MALBEK's talk)

P. Finnerty, Ph.D. thesis.



MALBEK is an ideal instrument to test CoGeNT (same detector design and mass, several parts provided by CoGeNT, identical ~160 eV FWHM intrinsic detector noise, similar background achieved)

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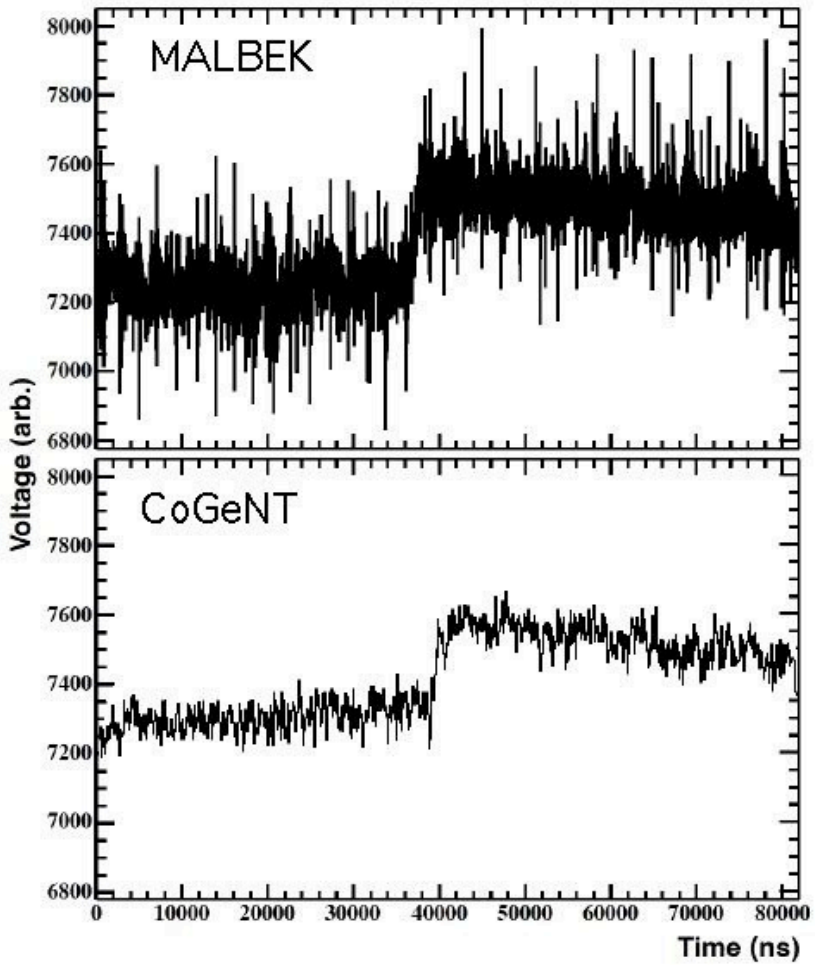

Typical 1.2 keVee pulses

Unfortunately, poor decisions in the choice of MAJORANA DAQ inject a dominant source of electronic noise. The above shows a comparison for a typical 1.2 keVee event in both, pre-denoising, following significant work to reduce polling noise in MALBEK. In a densely-packed MAJORANA-demonstrator array, noise performance can be expected to further degrade.

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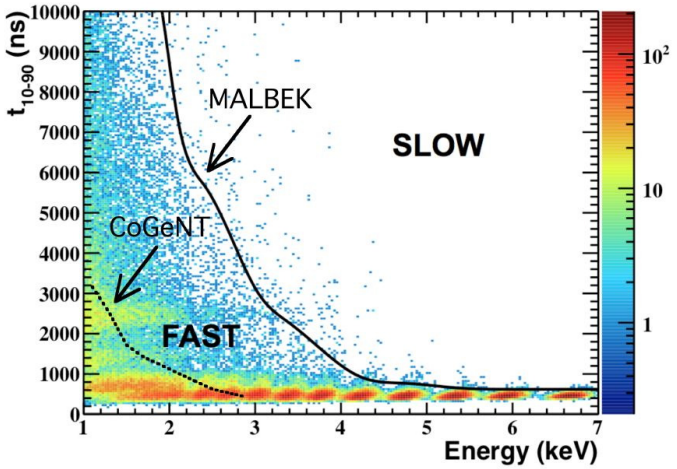
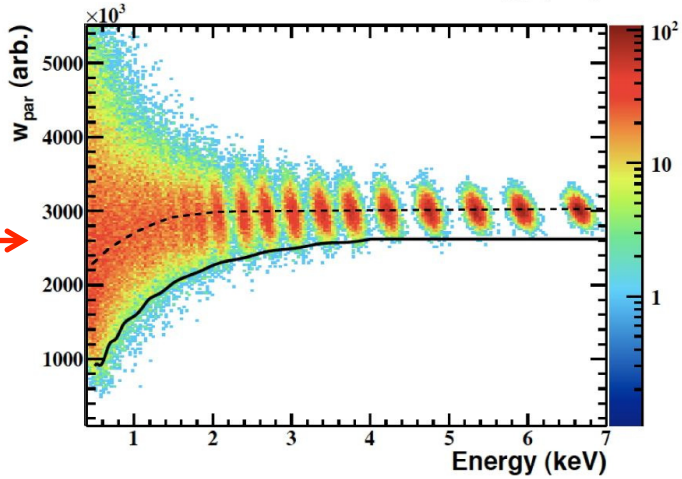
Adapted from
P. Finnerty, Ph.D. thesis.



99% SA boundaries
for fast pulser signals,
overlapped on
MALBEK's pulser data.

This shift is key.
Dotted line is
my estimated centroid.
(I am hoping this will be
duly emphasized in
MALBEK's talk.
Perhaps I am being naive)



As a result, MALBEK cannot measure preamplifier rise-times below ~2 keVee, i.e., at the energies of interest. A variable W_{par} derived from wavelet analysis is seen to correlate with r.t. at high energy, but rapidly becomes the same for surface and bulk events at low energy. MALBEK attempts to exploit W_{par} only down to 0.6 keVee (whereas CoGeNT measures true r.t. down to 0.5 keVee).

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Extracted from
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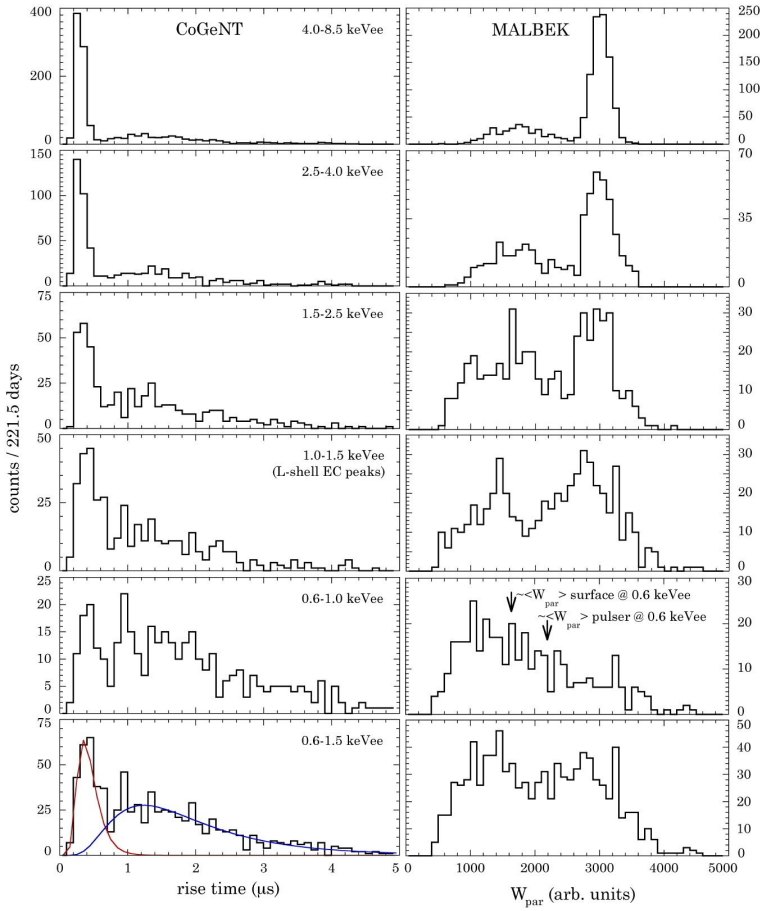

Fair comparison
(subset of CoGeNT
data selected to match
MALBEK's underground
exposure).

Full CoGeNT
dataset (x5 this exposure)
would display an
even crisper surface-bulk
separation
(see upcoming paper).

In the energy ROI (~<1.5 keVee) MALBEK's surface and bulk events are essentially indistinguishable, while CoGeNT preserves the ability to separate these down to threshold. Keeping in mind that the modulation observed in CoGeNT is a ~5% oscillation of the overall (surface + bulk) rate, a search for an annual modulation in MALBEK seems a futile exercise.

As a former MAJORANA collaborator, I should express my concern about the impact of DAQ hardware choices on its low-energy physics potential. See PRL 101 (2008) 251301 for a discussion of MAJORANA's potential as a low-mass WIMP detector.

Appendix: MALBEK and CoGeNT side-to-side

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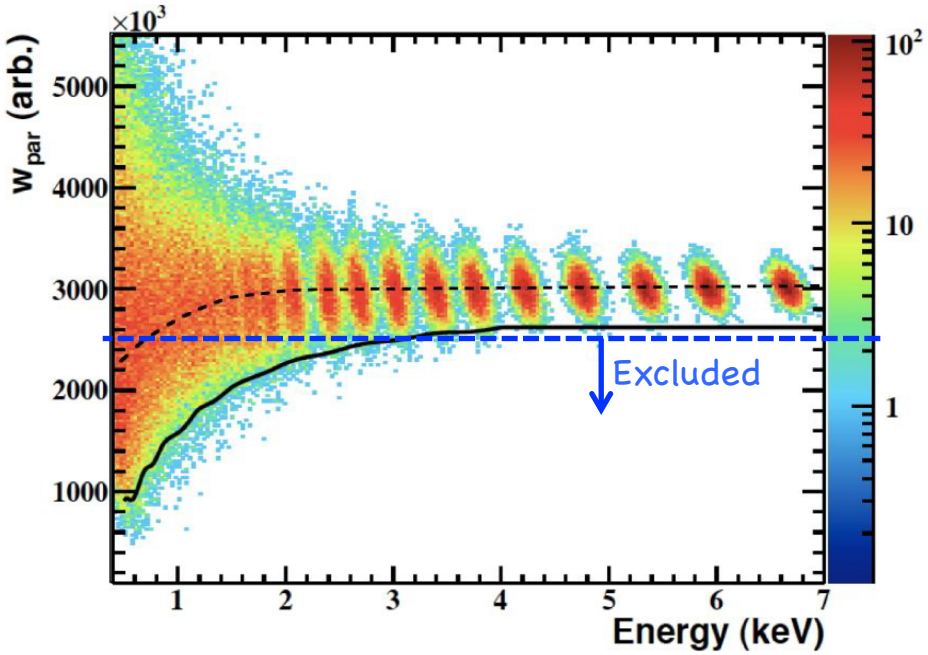
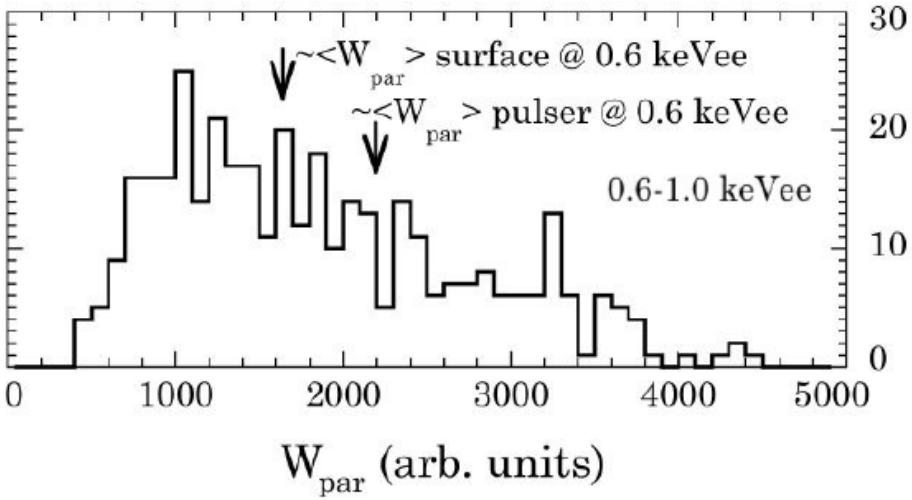


Trying to squeeze blood out of a turnip: an aggressive W_{par} cut runs the risk of throwing out baby and bathwater at low-E.



The larger statistics of CoGeNT (x5 MALBEK's) and much better surface-bulk separation produce little dependence of spectral shape and limits on choice of rise-time cuts. Quite the opposite for MALBEK (order of magnitude difference).

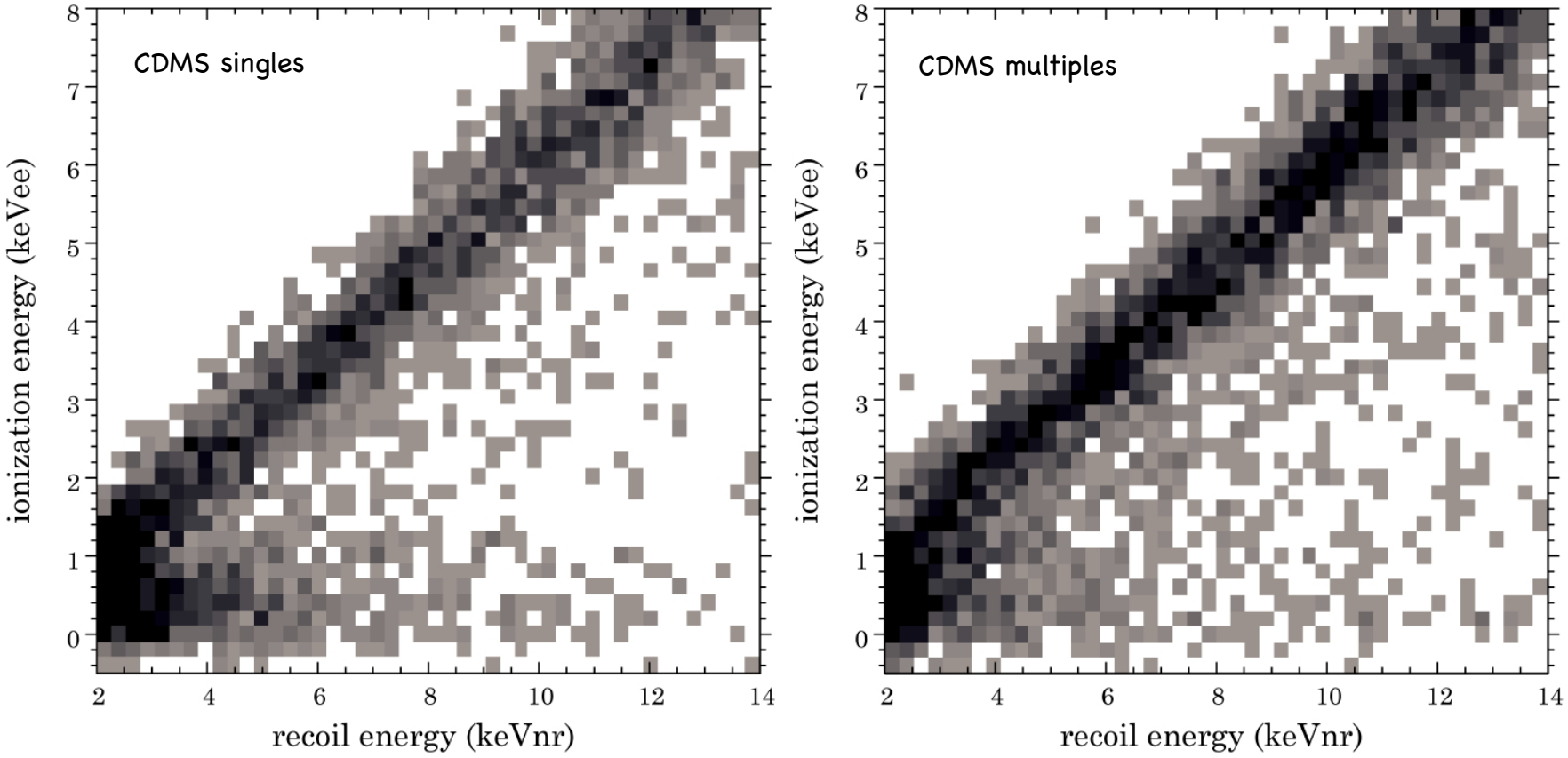
The low-E W_{par} distribution in MALBEK (see above) strongly points at roughly the same bulk and surface event contributions. In other words, a markedly exaggerated exclusion limit when applying aggressive W_{par} cuts.

MALBEK would do well in waiting to understand their low-E separation between surface and bulk events. This has been very beneficial for CoGeNT.

Reserve

Fair comparison

(same grayscale and number of events plotted)



CDMS-II data are now publicly available on ArXiv.